1330281

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DRAWINGS ATTACHED

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(19)

(54) METHOD OF INJECTION MOULDING DECORATIVE LAMINATE

(71) We, THE GENERAL TIRE & RUBBER COMPANY, of One General Street, Akron, County of Summit, State of Ohio, United States of America, a corporation organised under the laws of the State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to the field of fabricating processes for plastics. More particularly, this invention relates to the fields of injection moulding and vacuum forming of plastics laminates and to the products produced thereby.

The expansion of plastics from plain and simple articles, such as food trays, to more elegant objects, such as ornamental furniture and decorative wall tiles, has placed an increasing burden upon fabricators of these items to develop low-cost techniques that help keep the cost of manufacturing low. Fundamental limitations in conventional fabricating techniques such as the limited degree of draw and low production rate of vacuum forming, the high cost of mould making for injection moulding, and the low production rate of match moulding appear to have curtailed, to some extent, the rate at which plastics are being expanded into new fields.

Certain modifications have been made to conventional injection moulding to increase its versatility and scope of products. For instance, the inherent limitation of product size has been overcome in some instances by assembling preformed pieces in the mould and injection moulding along their mating edges to bond them into a large article. The inherent limitation of moulding thin sections has been overcome in part by prepositioning a thin strip of plastics at the location of the thin section and injection moulding around it (United States Patent 3,424,837).

This invention is another modification of conventional injection moulding wherein a modified injection mould is incorporated in a method that combines the wide range of decorative finishes available in vacuum forming with the high production rate of injection moulding.

According to this invention we provide a method of molding an article in an injection molding device comprising, in combination, cooperating first and second mold members each having a mold surface defining a mold cavity therebetween when closed, means for transferring fluid into and out of said mold cavity through the mold surface of said first mold member, and means in said second mold member allowing the injection of a charge of molten plastics into said cavity, comprising the steps of: placing a film or sheet of vacuum formable material (as herein defined) over the mold surface of said first mold member and against the perimeter defined thereby; vacuum forming said film or sheet of material against said mold surface of said first mold; closing said first and second mold members to envelop said film or sheet of material before or after said vacuum forming and injecting the charge of molten plastics into said cavity against the opposite side of said film or sheet of material to that adjacent the first mold surface to fill said cavity and to form said article.

By "vacuum formable material" we mean film or sheet material which is substantially flat but which, after subjection to vacuum forming against a mold surface, conforms at least in part to the contour of the mold surface and retains that shape after the vacuum forming is complete.

One embodiment of the invention and modifications thereof will now be described with reference to the accompanying drawings, wherein: —

Figure 1 is a cross-sectional view of an injection moulding device showing the first and second mold members in an open position and the step in the moulding process

polyether polyol with an organic isocyanate, and optionally water, blowing agents, catalysts, and surface active agents, casting the mixture into a sheet, and applying heat thereto. These and other thermoplastics and thermosetting plastics sheets and films are fully operable and contemplated herein.

The primary reason for using sheet 41 is to place a decorative finish on the molded part without going to the expense of cutting a negative of the decorative finish into the mold surface. The use of sheet 41 also permits changing the decorative finish without changing molds. The decorative finishes that may be placed on sheet 41 include the finishes normally placed on plastics film and sheeting such as embossed patterns, silk screened patterns, printed patterns, photographed patterns, hand painted patterns, etc. Specific examples of these include embossed and painted simulated wood grain finish, embossed and painted simulated leather finish, painted foam finish, silk screened or printed finishes, patent leather finish, and suede finish.

As is described earlier, sheet 41 is vacuum formed onto mold surface 7 prior to injecting a charge of molten plastics against it to form the article. Because film and sheeting exists in various strengths and stiffnesses, it may become necessary to augment the vacuum forming step with well-known practices that are fully within the ability of one skilled in the molding art. For instance, with stiff or high modulus film and sheeting, it is likely that softening of sheet 41 will be needed to permit vacuum forming without tearing or loss of embossed design. Conversely, with flexible or low modulus film and sheeting, such a softening step will not be needed, in fact, it may not be permitted in order to maintain the embossed design. When softening is desired, heating means 45 is utilized to direct hot air or other fluid over sheet 41 as shown in Figure 2.

Heating means 41 may comprise other types of heating units than is shown in Figure 2. For instance, a bank of CAL-ROD* heaters or high-intensity lights may be used. In addition, a radioactive source may be used. All these are fully contemplated herein.

The plastics injected into cavity 15 by the injection molding machine comprises all types of thermoplastic injection moldable plastics such as polystyrene, styrene-acrylonitrile (SAN), acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), polyvinyl acrylate, cellulose acetate, polyethylene, polyacrylics, nylon, polycarbonates, and polypropylene. Others include thermosetting plastics such as urea-formaldehyde resins.

An important aspect in this process is to obtain a good bond between the injection molded plastics and the sheeting. In many instances a good bond is obtained without special treatment such as in molding styrene-acrylonitrile plastic against a decorative vinyl film. In other cases the degree of bonding is less than that desired and is enhanced by placing a coating of adhesive on the surface of sheet 41 that faces cavity 15. As a specific example, to increase the degree of bonding between a vinyl film and an injection molded acrylonitrile-butadiene-styrene (ABS) resin, a coating of ATLAS* SY71.11 adhesive, made by Atlas Coatings Corporation, Long Island, New York, is applied to the vinyl film and dried prior to placing the film in the mold. Examples of other adhesives include acrylics, alkyds, bitumens, casein, cellulose acetate, ceilulose caprate, cellulose nitrate, cyanoacrylate epoxy-polyamide, phenolic-polyamide, phenolic-vinyl, polyamide, polyisobutylene, polystyrene, polyvinyl acetal, polyvinyl acetate, rosin, epoxides, furanes, melamine-formaldehyde, oleoresins, phenolformaldehyde, phenolic-epoxy, phenolic-neoprene, phenolic-nitrile, polyesters, polyurethanes, resorcinol-formaldehyde, urea-formaldehyde, polychloroprene, and acrylonitrile-butadiene. These may be applied in a wide variety of processes such as spraying, roll-coating and brushing.

Another important aspect of this process is encountered when molding against a highly sculptured surface as shown in Figure 5. As is known in the vacuum forming art, it is essential to draw the film into full conformity with the surface to obtain a high degree of fidelity or reproduction of the surface. As incorporated in this process, it was initially noted that full vacuum forming against a highly sculptured surface was virtually impossible because of the extreme detail of the surface and the inherent limitation in the number of air transfer channels 23 that could be drilled into surface 7 without damaging the sculptured effect. It was also thought that high pressure against vacuum formed fibers would smooth out the embossed design. It was therefore surprising to find that if sheet 41 were only partially vacuum formed against surface 7, the charge of molten plastics under high pressure from the injection molding machine would complete the surface forming without loss of surface definition. It was thus found that this aspect of the invention permited the inherent limitation of a limited degree of draw and a limited degree of surface sculpturing, occasioned in conventional vacuum forming, to be overcome and permitted manufacture of decorative laminates having highly sculptured surfaces. One must be particularly careful, however, to apply only the minimum

* "Cal-Rod" is a Registered Trade Mark.

* "Atlas" is a Registered Trade Mark.

amount of heat necessary to soften sheet 41 to permit partial vacuum forming against the highly sculptured surface and maintain only the minimum temperature of the molten plastics charge to insure adequate melt flow and mold cavity fill. Higher temperatures and/or over softening of sheet 41 may result in loss of embossing during injection molding. These skills are fully within the ambit of one skilled in the molding art.

A still further aspect of this process is that at least some degree of vacuum forming must be accomplished prior to injecting the charge of molten plastics into cavity 15. Tests have shown that if sheet 41 is not at least partially formed upon mould member closure the sheet comes in contact with sprue 37, then, upon injection, the molten plastic burns through sheet 41 in front of sprue 37 and accumulates plastics on both sides of the sheet to bury it in the article and render it useless.

We have found that the products produced by the process described above may obtain the benefits of the wide variety of surface patterns and textures attributable to the preformed sheet material, a wide range of surface features from almost planar to highly sculptured attributable to the capability of injection moulding techniques, and the low cost of fabrication stemming from the injection moulding system. Furthermore, injection moulded articles having both rigid and soft surfaces, the latter stemming from vacuum formable sheet material of the polymeric foam variety, have been found to be available from this invention.

Thus it will be seen from the foregoing description that we have found that this invention can result in a method of fabricating improved decorative laminar structures both plain and elegant. The inherent limited degree of draw and low production rate of vacuum forming was found to be overcome, as well as the high cost of textured mould making for injection moulding and a new, low-cost fabricating technique may thus be made available to the plastics industry.

WHAT WE CLAIM IS:—

1. A method of molding an article in an injection molding device comprising, in combination, cooperating first and second mold members each having a mold surface defining a mold cavity therebetween when closed, means for transferring fluid into and out of said mold cavity through the mold surface of said first mold member, and means in said second mold member allowing the injection of a charge of molten plastics into said mould cavity, comprising the steps of:

a) placing a film or sheet of vacuum formable material (as herein defined) over the mold surface of said first mold member and against the perimeter defined thereby;
b) Vacuum forming said film or sheet of material against said mold surface of said first mold;
c) closing said first and second mold members to envelop said film or sheet of material before or after said vacuum forming; and,
d) injecting the charge of molten plastics into said cavity against the opposite side of said film or sheet of material to that adjacent the first mold surface to fill said cavity and to form said article.

2. The method of Claim 1 including the step of softening said film or sheet of vacuum formable material prior to vacuum forming it against said mold surface.

3. The method of Claim 1 or 2 wherein said step of vacuum forming said sheet of material against said mold surface of said first mold member is carried to the extent that said film or sheet is only partially vacuum formed.

4. The method of Claim 1 or 2 wherein said step of vacuum forming said sheet of material against said mould surface of said first mould member is carried to the extent that said sheet is fully vacuum formed.

5. The method of any one of the preceding Claims including the subsequent step of opening said first and second mould members and transferring air to said mould cavity, through said mould surface of said first mould member, to separate said article from said mould surface and eject said article from said injection moulding device.

6. The method of any one of the preceding Claims wherein said sheet of vacuum formable material contains a coating of adhesive on the surface facing said mould cavity.

7. The method of any one of the preceding Claims wherein said vacuum formable material comprises a thermoplastic.

8. The method of Claim 7 wherein said sheet of vacuum formable material comprises a foamed thermoplastic.

9. The method of any one of Claims 1 to 6 wherein said vacuum formable material comprises a polymeric foam.

10. The method of Claim 9 wherein said vacuum formable material comprises a polyurethane foam.

11. The method of Claim 7 wherein said vacuum formable material comprises a fabric-backed thermoplastic.

12. A method of moulding an article in an injection moulding device according to Claim 1 substantially as described herein.

13. An article produced by the method of any one of Claims 1 to 12.

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1330281 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

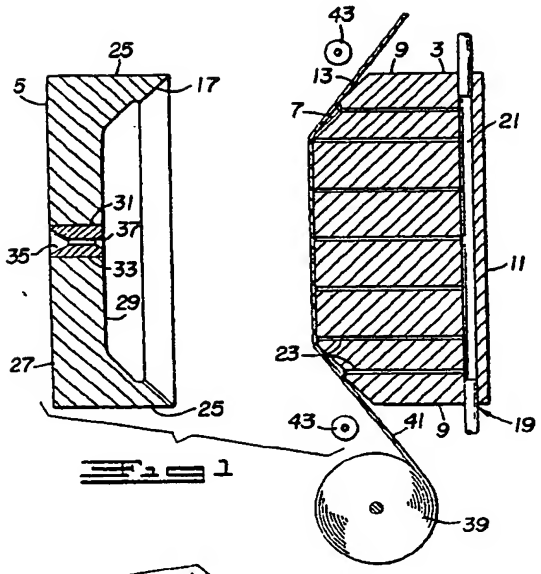


Fig 1

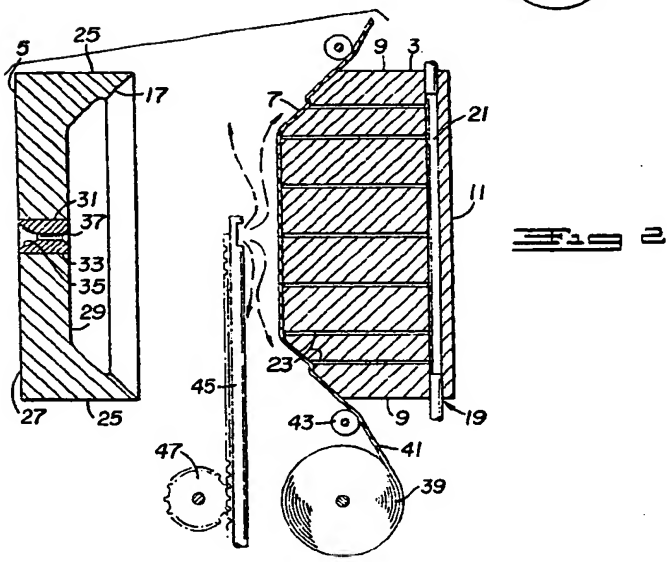


Fig 2

1330281 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

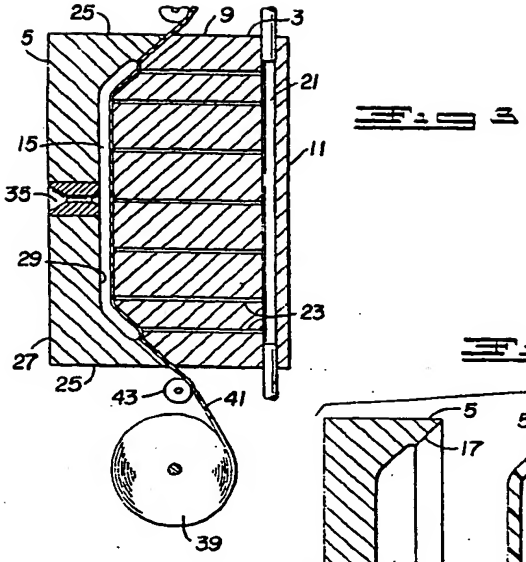
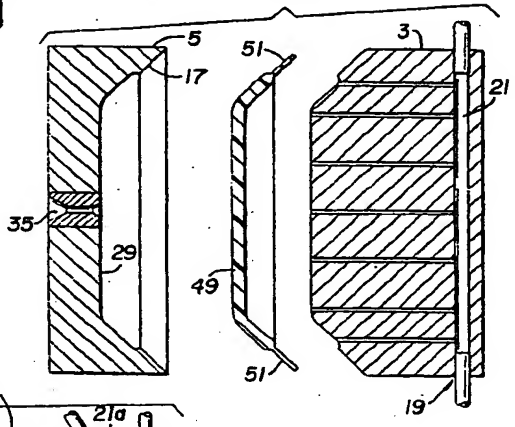


Fig 3

Fig 4



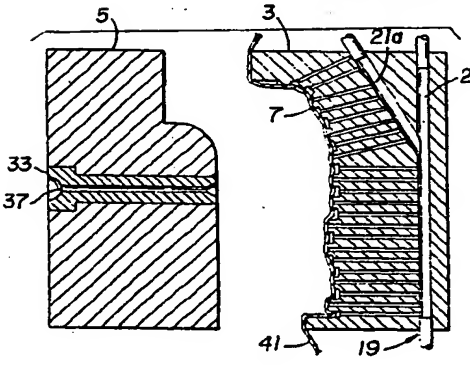


Fig 5